THE EFFECT OF HERBICIDES ON PHYTOPLANKTON IN WAZIMENYA BAY, L. VICTORA

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SUMMARY:

During the in-lake herbicide trials in Wazimenya Bay, Cyanobacteria dominated the phytoplankton, constituting more than 85%. The green algae and diatoms were always rare. There was a low species diversity.

Algal cell counts were generally lower below the Hyacinth mat (5m inside) than at the edge (0m). There was no significant difference in the cell counts from the Rodeo and Weedar-64 sprayed stations nor between those from the Weedar-64 and control stations.

However, there was a significant difference in the counts between Rodeo and control stations. But, the control counts were almost always lower than the Rodeo counts, an observation which could not easily be explained.

1.0 Introduction

This short study attempts to investigate the effect of hervicides: Rodeo and Weedar-64 on the quality and quantity of phytoplankton in Wazimenya Bay, where in-lake herbicide trials have been carried out on the notorious aquatic weed, *Eichhornia crassipes*, commonly known as the Water Hyacinth.

Phytoplankton in an aquatic ecosystem carry out primary productivity. This involves the process of photosynthesis, during which light energy is captured and transformed into chemical energy. Sugars are manufactured and converted into complex carbohydrates. This biomass, together with the chemical energy are then readily available to the primary consumers (the zooplankton and fish) which directly feed on the phytoplankton (the primary producers). During photosynthesis oxygen is passed out as a by-product and is readily available to the other living organisms for respiration.

Since algae are plants, they are sensitive to herbicides. These could affect their quality and/or quantity. Because they are microorganisms, the effect of these chemicals on them could be more felt than in the macrophyte vegetation.

It was therefore fitting that while these spray trials were being carried out, a concurrent ecological study be carried out on the phytoplankton to avoid an ecological catastrophe should the chemicals destroy these organisms.

2.0 Materials and Methods

2.1 The Study area

The in-lake trials together with this short phytoplankton study were carried out in Wazimenya Bay, a smaller Bay of Murchison Bay north of Lake Victoria.

2.2 Methods

Water samples were collected with an intergrated 0.5-litre water sampler from five sampling statios labelled A, B, C, D, and E. Stations A and D were sprayed with Rodeo, B and C with Weedar-64 and E was the control (not sprayed).

The samples were collected a day before spraying and then 2 hours, 1 day, 2 days, 7 days, 14 days, 21 days and 30 days after spraying. From each station water was obtained from the edge of Hyacinth mat (0m) and 5m inside the mat (in the sprayed zone). The water was then emptied into plastic sample bottles and then fixed with Lugol's Iodine to preserve the algal cells.

In the laboratory, 1 ml from each sample was placed in a Sedgewick Rafter cell (counting chamber). The chamber was then placed under the microscope. Algal cells were indentified and quantified.

3.0 Results

During this study major phyla of algae, namely *Cyanobacteria* (blue-green algae), Chlorophyta (green algae) and Bacillariophyta (diatoms) were represented (Table 1)

Table 1 Algal species found in Wazimenya Bay (L. Victoria) during the herbicide trials

* = abundant

Cynabacteria (Blue-gree algae)

Anabaenopsis sp. (*)

**Merismopedia glauca*

**Microcystis aeruginosa*

**Spirulina* spp.

Chlorophyta (green algae)

Pandorina sp.

Pediastrum spp.

Scenedesmus spp.

Staurastrum spp.

Bacillariophyta (Diatoms)

Cocconeis placentula

Navicula spp.

**Nitzschia* sp.

The blue-gree algal flora dominated the phytoplankton throughout the period of study, both before and after spray. They formed more than 85% of the algal population. The diatoms formed about 15% while the green algae were just negligible throughout the study (Table 2).

Table 3 shows the average algal cell counts in the Rodeo, Weedar-64 and control sampling stations. Counts from samples collected before and after spray were generally higher at the edge of the mat (0m) than inside the mat (5m inside). Using the Student's t-test, the results of cell counts from the Rodeo stations (A and D) were not significantly different from the Weeder-64 (B and C) counts. Nor were those from Weedar-64 and control stations significantly different. However, there was a significant difference in the results from Rodeo and Control Stations.

Table 2: Showing algal cell counts (cells/ml) during the period of study.

PRE-SPTAYING DAY (10-2-97)

Algal species	A-Rodeo 0m	A-Rodeo 5m	D-Rodeo 0m	D-Rodeo 5m	B-Weedar 64 0m	B-Weedar 64 5m	C-Weeder 64 0m	C-Weeder 64 5m	E-Control 0m	E-Control 5m
Blue Green Algae										
Anabaenopsis spp	1026	378	486	594	558	18	126	90	486	72
Merismopedia spp	666	360	180	144	216	90	486	54	252	216
Microcystis spp	5598	4032	2340	1350	2952	1188	1908	2340	4896	684
Spirulina spp	72	18	72	72	90	36	36	0	0	0
Green Algae										
Pandorina spp	36	0	0	0	0	0	0	0	0	0
Pediastrum spp	0	0	0	0	0	0	0	0	0	0
Scenedesmus spp	0	0	0	18	0	0	0	0	0	0
Staurastrum spp	0	0	0	0	0	0	0	0	0	0
Diatom species:										
Cocconeis spp	0	0	0	0	0	0	0	0	0	0
Navicula spp	0	0	0	0	0	0	0	0	0	0
Nitzschia spp	0	0	0	0	0	0	0	0	0	0
Totals:	**8046**	**5095**	**3528**	**2448**	**4284**	**1566**	**3258**	**2628**	**5706**	**1674**

Table 2 ctd.

2 HOURS AFTER SPRAYING (11-2-97)

Algal species	A-Rodoe 0m	A-Rodoe 5m	D-Rodeo 0m	D-Rodeo 5m	B-Weedar 64 0m	B-Weedar 64 5m	C-Weeder 64 0m	C-Weeder 64 5m	E-Control 0m	E-Control 5m
Blue Green Algae										
Anabaenopsis spp	1098	864	882	-	864	252	792	216	72	342
Merismopedia spp	432	342	414	-	270	990	162	468	324	288
Microcystis spp	7902	10746	774	-	8046	10260	2790	5922	3078	3090
Spirulina spp	198	90	18	-	90	54	108	36	54	54
Green Algae										
Pandorina spp	0	0	0	-	0	0	0	36	0	0
Pediastrum spp	0	0	0	-	0	0	0	0	0	0
Scenedesmus spp	0	0	0	-	18	18	18	18	0	18
Stamastum spp	0	0	0	-	0	0	0	0	0	0
Diatom species:										
Cocconeis spp	0	0	0	-	0	0	0	18	0	0
Navicuia spp	0	0	0	-	0	0	0	0	0	0
Nitzschia spp	0	0	18	-	0	0	0	0	0	0
Totals:	**10404**	**12510**	**2412**	**-**	**9288**	**12204**	**4230**	**7002**	**3798**	**4350**

Table 2. Cont.

1 DAY AFTER SPRAYING (12-2-97)

Algal species	A-Rodeo		D-Rodeo		B-Weedar 64		C-Weeder 64		E-Control	
	0m	5m	0m	5m	0m	5m	0m	5m	0m	5m
Blue Green Algae										
Anabaenopsis spp	1638	720	1872	196	1044	36	1242	0	1710	0
Merismopedia spp	360	234	450	216	432	126	468	198	486	432
Microcystis spp	4050	4230	3744	3996	7308	882	2232	486	5472	2070
Spirulina spp	72	36	144	36	108	0	36	0	108	0
Green Algae										
Pandorina spp	36	36	0	18	18	0	0	0	0	18
Pediastrum spp	0	18	0	0	0	0	0	0	0	0
Scenedesmus spp	0	0	0	18	0	0	18	0	18	0
Staurastrum spp	0	0	0	0	0	0	0	0	0	0
Diatom species:										
Cocconeis spp	0	0	0	0	0	0	0	0	0	0
Navicula spp	0	0	18	0	0	0	18	0	18	0
Nitzschia spp	486	360	468	342	522	252	486	0	792	504
Totals:	**6642**	**5580**	**6696**	**4822**	**9432**	**1296**	**4500**	**684**	**8604**	**3024**

Table 2. Cont.

2 DAY AFTER SPRAYING (13-2-97)

Algal species	A-Rodoe		D-Rodeo		B-Weedar 64		C-Weeder 64		E-Control	
	0m	5m	0m	5m	0m	5m	0m	5m	0m	5m
Blue Green Algae										
Anabaenopsis spp	900	1098	-	-	810	270	630	396	846	774
Merismopedia spp	216	144	-	-	234	54	432	126	126	144
Microcystis spp	1890	4140	-	-	2340	540	450	2610	2934	1368
Spirulina spp	0	54	-	-	18	0	0	0	0	0
Green Algae										
Pandorina spp	0	0	-	-	0	0	0	0	0	0
Pediastrum spp	0	0	-	-	0	0	0	0	0	0
Scenedesmus spp	18	36	-	-	18	0	54	18	0	0
Staurastrum spp	0	18	-	-	0	0	0	0	0	0
Diatom species:										
Cocconeis spp	0	18	-	-	0	0	72	0	0	18
Navicula spp	0	0	-	-	0	0	54	18	0	0
Nitzschia spp	738	648	-	-	756	468	378	468	810	828
Totals:	**3762**	**6156**	-	-	**4176**	**1332**	**2070**	**3636**	**4716**	**3132**

Table 2. Cont.
14 DAYS AFTER SPRAYING (13-2-97)

Algal species	A-Rodoe 0m	A-Rodoe 5m	D-Rodeo 0m	D-Rodeo 5m	B-Weedar64 0m	B-Weedar64 5m	C-Weeder64 0m	C-Weeder64 5m	E-Control 0m	E-Control 5m
Blue Green Algae										
Anabaenopsis spp	-	1530	8442	990	1998	1026	1584	612	2934	1206
Merismopedia spp	-	324	216	144	234	306	324	270	108	234
Microcystis spp	-	1620	1350	2988	4572	1530	1710	2664	3150	990
Spirulina spp	-	54	36	36	54	0	54	0	252	90
Green Algae										
Pandorina spp	-	0	0	0	0	0	36	0	0	0
Pediastrum spp	-	0	0	18	18	18	0	0	0	0
Scenedesmus spp	-	0	0	18	0	18	0	0	0	0
Stauastrum spp	-	0	0	0	18	0	0	0	0	0
Diatom species:										
Cocconeis spp	-	0	0	0	0	0	0	0	0	0
Navicula spp	-	18	0	0	0	0	0	0	0	0
Nitzschia spp	-	1206	990	486	1080	1044	702	72	1314	918
Totals:	-	4752	11034	4680	7974	3942	4410	3618	7776	3438

Table 2, Cont..
21 DAY AFTER SPRAYING (4-3-97)

Algal species	A-Rodoe 0m	A-Rodoe 5m	D-Rodeo 0m	D-Rodeo 5m	B-Weedar64 0m	B-Weedar64 5m	C-Weeder64 0m	C-Weeder64 5m	E-Control 0m	E-Control 5m
Blue Green Algae										
Anabaenopsis spp	3024	1062	378	732	972	1008	828	324	648	468
Merismopedia spp	342	126	162	234	144	162	54	18	108	126
Microcystis spp	1890	2340	180	4410	1098	1620	2070	900	810	126
Spirulina spp	36	36	18	18	18	0	18	0	0	0
Green Algae										
Pandorina spp	0	18	36	0	0	0	18	0	0	0
Pediastrum spp	0	0	0	0	0	0	18	0	0	0
Scenedesmus spp	36	18	72	54	36	90	18	54	36	72
Staurastrum spp	0	0	0	0	0	0	0	0	0	18
Diatom species:										
Cocconeis spp	0	0	0	18	0	54	36	18	0	18
Navicula spp	0	0	0	0	0	0	0	0	0	0
Nitzschia spp	360	234	162	234	234	90	162	126	162	234
Totals:	5688	3834	1008	5400	2502	3042	3222	1458	1764	1062

Table 2, Cont..
30 DAY AFTER SPRAYING (4-3-97)

Algal species	A-Rodoe		D-Rodeo		B-Weedar64		C-Weeder64		E-Control	
	0m	5m	0m	5m	0m	5m	0m	5m	0m	5m
Blue Green Algae										
Anabaenopsis spp	1116	126	4086	3042	3348	36	3456	90	2196	1080
Merismopedia spp	144	36	270	324	342	396	234	504	90	162
Microcystis spp	2088	1080	306	1080	4266	360	1800	1620	1170	540
Spirulina spp	54	18	54	36	18	0	162	0	0	36
Green Algae										
Pandorina spp	0	0	0	0	0	0	0	0	0	0
Pediastrum spp	0	0	0	0	0	18	0	0	0	18
Scenedesmus spp	126	36	36	0	54	0	0	54	0	0
Staurastrum spp	0	0	0	0	0	0	0	0	0	0
Diatom species:										
Cocconeis spp	0	0	0	18	0	18	0	0	0	0
Navicula spp	0	18	36	0	0	0	0	0	18	0
Nitzschia spp	144	126	648	252	324	126	450	288	306	180
Totals:	**3672**	**1440**	**5436**	**4752**	**8352**	**954**	**5102**	**2556**	**3780**	**2016**

Table 3 Average algal cell counts in Rodeo, Weedar-64 sprayed and control sampling stations

	RODEO		WEEDAR-64		CONTROL	
Time after spray	0m	5m	0m	5m	0m	5m
Pre-spray	5787	3772	3771	2097	5706	1674
2 hours after	6408	6255	6759	9603	3798	4350
1 day after	6669	5201	6966	990	8604	3004
2 day after	6768	3031	8550	4806	8676	6804
7 day after	3762	6156	3123	2484	4716	3132
14 days after	5517	4716	6192	3780	7776	3438
21 days after	3348	4617	2862	2250	1764	1062
30 days after	4554	3096	6727	1755	3780	2016

4.0 Discussion

The observation that blue-green algae now dominate the phytoplankton flora in Lake Victoria is as a result of recent changes in the physico-chemical nature of the lake water and the general global climatic changes.

Up to the late 1970's Lake Victoria phytoplankton was dominated by diatoms, namely *Melosira (Aulacoseira)* species. Of recent, inputs into the lake from the mushrooming industries, fish processing plants, and surface run-off from cultivated land surrounding the

Melosira (Aulacoseira) species. Of recent, inputs into the lake from the mushrooming industries, fish processing plants, and surface run-off from cultivated land surrounding the lake add a lot of arganic and inorganic nutrients into the lake, making it more eutrophic. The recent outbursts of the notoroius *Eichhornia crassipes* have led to high rates of decomposition which ultimately results in reduced oxygen levels. All the above encourage flourishing of the blue-green algal flora while other forms of algae reduce in abundance.

Because of the general global warming phenomenon, the deep waters of this lake no longer undergo complete mixing. The algae, particularly the heavy diatom cells which are normally redistributed to the surface by the vertical water movements have remained in the dark, bottom mud where they have contiued to perish, leaving the blue-greens to dominate the phytoplantkon biomass.

At each sampling site, both before and after spray, there was a higher algal count at the edge (0m) of the water hyacinth mat than at 5m inside the weed mat (Table 3). Algal cells are photosynthetic and therefore need light for the process. Some of these cells are motile and can thus move to the lighted areas, away from the mat.

However, the reduction in numbers in the mat (the sprayed areas) could also be a result of the effect of the herbicides. But, in the control station E, the observation of lower algal counts under the mat could not be attributed to the effect of the chemicals, since the station was not sprayed.

The significant difference between counts from Rodeo and control stations is also questionable because the difference was due to the fact that the counts in the control station E were generally lower than in Rodeo stations, A and D. The counts in E should not have been lower than in A and D since E was not sprayed. Also, one would have expected higher cell counts before spray (pre-spray) but this was not the case in almost all stations.

The fact that this area of study remained part of the large body of the whole lake complicated the observations. Thus, the herbicides sprayed could not have an obvious effect as they would have in isolated culture experiments with known concentrations of the herbicide(s). Even under the mat, horizontal water movements continue to transport algal cells. Cells picked after spray were not necessarily the ones that were there before the spray! The dilution effect of this large water body was another loophole of these observations. Thus, no concrete conclusion or recommendation can be drawn from these in-lake trial observations!